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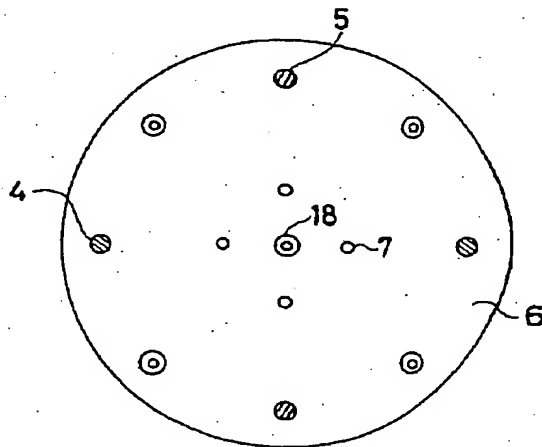
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(54)【発明の名称】 ホットプレート

(57)【要約】

【目的】 シリコンウェーハ等の試料の高精度かつ均一な高温加熱を可能としたホットプレートの提供。

【構成】 熱分解窒化ほう素からなる基材(1)の一方の面に静電チャック用電極(2)が、他方の面に加熱用電極(3)がいずれも熱分解黒鉛で形成されてなり、しかも静電チャック用電極の給電部(4)と加熱用電極の給電部(5)を除く部分に熱分解窒化ほう素被覆膜(6)が施されてなることを特徴とするホットプレート。



## 【特許請求の範囲】

【請求項1】 熱分解窒化ほう素からなる基材(1)の一方の面に静電チャック用電極(2)が、他方の面に加熱用電極(3)がいずれも熱分解黒鉛で形成されてなり、しかも静電チャック用電極の給電部(4)と加熱用電極の給電部(5)を除く部分に熱分解窒化ほう素被覆膜(6)が施されてなることを特徴とするホットプレート。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は、導電材料や半導体材料からなるシリコンウェーハ等の試料に集積回路を形成する工程において、試料の加熱に使用するに好適なホットプレートに関する。

## 【0002】

【従来の技術】シリコンウェーハ等の試料に層間絶縁膜や保護膜を形成する工程においては、化学気相蒸着(CVD)法が用いられる。CVD法では、反応温度に加熱された試料と反応ガスが接触することにより、試料上で化学反応が生じて膜が形成される。膜の材質は反応ガスの種類によって選定され、さらに膜質や膜厚はCVDの圧力、温度、プラズマの有無等の条件で調節される。そして、CVDの温度は、抵抗加熱、誘導加熱、赤外線加熱等の方法で制御される。特に試料を1枚ずつホットプレートで加熱する方法は枚葉式と呼ばれ、温度を高精度で制御するのに適した方法である。

【0003】しかしながら、従来の枚葉式の加熱においては、加熱により発生する試料のそりによって試料とホットプレートの接触が不均一となって試料面内に温度分布が生じ膜質や膜厚の分布が不均一になるという問題があった。これを改善すべく試料とホットプレートとの間に熱を伝達しやすいベリウム等の不活性ガスを介在させることを試みたが、CVDは減圧下で行なわれる場合が多く、不活性ガスの圧力を高くすることができないため、十分な効果は得られなかった。

## 【0004】

【発明が解決しようとする課題】本発明の目的は、上記欠点を解決し、高精度かつ均一な試料の高温加熱を可能としたホットプレートを提供することにある。

## 【0005】

【課題を解決するための手段】すなわち、本発明は、熱分解窒化ほう素からなる基材1の一方の面に静電チャック用電極2が、他方の面に加熱用電極3がいずれも熱分解黒鉛で形成されてなり、しかも静電チャック用電極の給電部4と加熱用電極の給電部5を除く部分に熱分解窒化ほう素被覆膜6が施されてなることを特徴とするホットプレートである。

【0006】以下、さらに詳しく本発明を説明する。本発明のホットプレートの一例を示す平面図を図1に、それを装備した枚葉式CVD装置の概略断面図を図2に示

す。

【0007】本発明で使用する基材1は熱分解窒化ほう素(P-BN)からなるものである。P-BNとはCVD法で形成されてなる窒化ほう素(BN)である。基材1としてP-BN以外の材料を用いると、CVD時に基材自体の熱分解もしくは基材と反応ガスとの反応が生じるため好ましくない。また、BN焼結体を基材に用いることも考えられるが、BN焼結体は機械的強度が小さいために基材の厚さを厚くしなければならず、しかも基材側面から逃げる熱量も大きいので特に700℃よりも高い温度に試料を加熱しようとする場合に温度が充分に上がらないという問題があった。

【0008】基材1の厚さがあまりにも薄いと、静電チャック用電極と加熱用電極との間の絶縁が不充分となるし、またあまりにも厚いと、厚さ方向に熱が伝わりにくくなって温度制御の精度が低下するので、0.5～1.0mmが好ましい。P-BNを基材に用いた場合、静電チャックにそりが発生することがあるが、P-BNは弾力性に富むため、枚葉式CVD装置に装備する際にネジ等を用いて力を加えながら固定することにより容易にそれを矯正することができる。

【0009】本発明のホットプレートは、上記基材の一方の面に静電チャック用電極2を、他方の面に加熱用電極3をそれぞれ熱分解黒鉛(PG)で形成することを要件としている。PGとはCVD法で形成されてなる黒鉛をいう。

【0010】PG以外の材料で上記の電極2又は3を形成したのでは、P-BN被覆膜6を形成する際やホットプレートの使用時におけるような高温下においては上記の電極2又は3と基材1とが反応したり、あるいは両者の熱膨脹率の違いにより電極が断線したり剥離したりする。

【0011】静電チャック用電極2又は加熱用電極3の厚さとしては、あまりにも薄いと、加熱用電極の抵抗値が大となって加熱電源に過大な電圧が必要となるし、一方、あまりにも厚いと、電極が基材から剥離しやすくなるので、10μm～1mmとするのが好ましい。

【0012】本発明において、静電チャック用電極の給電部4と加熱用電極の給電部5以外の部分をP-BN被覆膜で構成する理由は、静電チャック力を低下させないこと及び試料上の素子が漏電等により破壊されるのを防止するためである。P-BN被覆膜とはCVD法で形成されてなるBN被覆膜をいい、その膜厚としては10μm～1mmが好ましい。

【0013】本発明のホットプレートは、例えば、上記基材1にPGをCVD法により被覆後、機械加工等により不要なPG部分を除去して静電チャック用電極2と加熱用電極3を形成させ、さらにCVD法によりP-BN被覆膜6を設けた後、静電チャック用電極の給電部4と加熱用電極の給電部5となる部分のP-BN被覆膜を除

去することによって製造することができる。

【0014】CVD法は、反応室内に配置された基材上に、又は電極が形成された基材上に、窒素、アルゴンなどの不活性ガス雰囲気下、圧力0.1~50 torr、温度1700~2000℃の条件下で化学反応を起こさせ膜を形成させるものである。反応ガスとしては、PGでは、プロパン( $C_3H_8$ )、アセチレン( $C_2H_2$ )等の炭化水素ガスが、P-BNでは、三塩化ほう素( $BCl_3$ )等のハロゲン化ほう素とアンモニア( $NH_3$ )等の混合ガスが主に用いられる。

【0015】本発明のホットプレートを装備した枚葉式CVD装置の概略説明図を図2に示す。真空容器8内に本発明のホットプレート9が置かれ、試料10はホットプレート上に固定され、加熱される。試料は、静電チャック用電極に電圧を印加することによって発生した静電引力により固定され、加熱は、加熱用電源17からその給電部5を介して加熱用電極3に電流を流すことによって行なわれる。なお、18は静電チャック用電極面側に皿もみが設けられたネジ止め用小孔である。

【0016】本発明のホットプレートには、ホットプレートから試料への熱の伝達を均一にするため、ヘリウム等の不活性ガス11を導入するための小孔7を設けておくことが好ましい。不活性ガスを導入する場合、その圧力が試料の単位面積あたりの静電引力をこえると試料が浮き上がるので注意が必要である。

【0017】上記のとおり試料が固定された後は、真空ポンプ13により排気口12から排気が行なわれ、真空容器内が一定圧力に保持される。さらにホットプレートが加熱され真空容器内が一定温度に保持される。その後、ガス導入口14より反応ガス15が導入され、試料表面にCVD膜が施される。

【0018】本発明のホットプレートの用途は、CVD法により、試料に層間絶縁膜や保護膜を形成する工程に限られるものではなく、例えばエピタキシャル成長、プラズマCVD、物理気相蒸着、プラズマエッチングなどの試料加熱処理工程に用いることができる。

【0019】

【実施例】以下、実施例と比較例をあげてさらに具体的に本発明を説明する。

【0020】実施例1

長さ500mm、幅250mm、厚さ5mmの黒鉛板からなる基材を反応容器内に置き、温度1950℃、圧力1 torrに保持して窒素ガスで希釈した三塩化ほう素とアンモニアの混合ガスを導入してP-BNのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、析出したP-BNを基材から離型した。得られたP-BN板の機械加工を行ない、外径200mm、厚さ2mmのP-BN円板を作製し基材とした。

【0021】上記P-BN円板からなる基材を反応容器内に置き、温度1850℃、圧力6 torrに保持後、窒素

ガスで希釈したプロパンガスを反応容器内に導入してPGのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、不要部分のPGを機械加工で除去し、一方の片面には静電チャック用電極を、もう一方の面には加熱用電極を形成した。電極のPGの厚さはいずれも50μmであった。

【0022】次いで、電極が形成された上記基材を再度反応容器内に置き、温度1950℃、圧力1 torrに保持後、窒素ガスで希釈した三塩化ほう素とアンモニアの混合ガスを導入して熱分解窒化ほう素(P-BN)のCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、静電チャック用電極の給電部と加熱用電極の給電部のP-BN除去及び表面の研磨仕上げを行なってホットプレートを作製した。なお、P-BN被覆膜の厚さは150μmであった。

【0023】上記ホットプレートを10<sup>-1</sup> torrの真空中で800℃に加熱し、静電チャック用電源からその給電部を介して静電チャック用電極に3KVの直流電圧を印加して150mmφシリコンウェーハの吸着試験を行なったところ、25 gf/cm<sup>2</sup>の静電吸着力が得られた。

【0024】次いで、上記ホットプレートを枚葉式CVD装置に静電チャック用電極側が上向きになるように取り付け付けた。150mmφシリコンウェーハをホットプレート上に置き、静電チャック用電極に3KVの直流電圧を印加してシリコンウェーハを固定し、装置内を真空排気しながら加熱用電極の給電部に電流を通じてシリコンウェーハを700℃まで加熱した。

【0025】温度がほぼ一定になった時点におけるシリコンウェーハ面内の温度分布は、±30℃のばらつきであった。その後、装置内の圧力を1 torrにして、モノシラン( $SiH_4$ )、アンモニア( $NH_3$ )及び水素( $H_2$ )の混合ガスを導入して窒化けい素( $Si_3N_4$ )のCVDを行なった。膜厚1μmの $Si_3N_4$ を析出させた後、シリコンウェーハ面内の $Si_3N_4$ の厚さ分布を測定したところ、±20%のばらつきがあった。

【0026】比較例1

静電チャック用電極を形成させないホットプレートを用いたこと以外は実施例1と同様にして試験した。その結果、温度がほぼ一定になった時点におけるシリコンウェーハ面内の温度分布は、±120℃のばらつきであった。また、膜厚1μmの $Si_3N_4$ を析出させた後のシリコンウェーハ面内の $Si_3N_4$ の厚さ分布は、±60%のばらつきであった。

【0027】実施例2

外径250mm、厚さ3mmのP-BN円板の中心から80mmの位置に等間隔に直径5mmの不活性ガス導入用小孔を4個あけた。その後、実施例1と同様にしてホットプレートを作製し、枚葉式CVD装置に取り付けてシリコンウェーハを加熱した。

【0028】シリコンウェーハの温度がほぼ一定になっ

た時点で、ホットプレートの不活性ガス導入用小孔よりヘリウムガスを5 torrの圧力で導入して1時間保持したところ、シリコンウェーハ面内の温度分布は、 $\pm 10^\circ\text{C}$ のばらつきであった。その後、装置内の圧力を1 torrにして、モノシラン( $\text{SiH}_4$ )、アンモニア( $\text{NH}_3$ )及び水素( $\text{H}_2$ )の混合ガスを導入して窒化けい素( $\text{Si}_3\text{N}_4$ )のCVDを行なった。膜厚 $1\mu\text{m}$ の $\text{Si}_3\text{N}_4$ を析出させた後、シリコンウェーハ面内の $\text{Si}_3\text{N}_4$ の厚さ分布を測定したところ、 $\pm 10\%$ のばらつきであった。

#### 【0029】比較例2

静電チャック用電極を形成させないホットプレートを用いたこと、及び小孔からのヘリウムガスの導入圧力を1 torrにしたこと以外は実施例2と同様にして試験した。その結果、ヘリウムガス導入1時間後のシリコンウェーハ面内の温度分布は、 $\pm 80^\circ\text{C}$ のばらつきであった。また、膜厚 $1\mu\text{m}$ の $\text{Si}_3\text{N}_4$ を析出させた後のシリコンウェーハ面内の $\text{Si}_3\text{N}_4$ の厚さ分布は、 $\pm 40\%$ のばらつきであった。

#### 【0030】実施例3

実施例2と同一の基材を反応容器内に置き、温度 $1900^\circ\text{C}$ 、圧力10 torrに保持後、窒素ガスで希釈したプロパンガスを反応容器内に導入してPGのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、不要部分のPGを機械加工で除去し、一方の片面には静電チャック用電極を、もう一方の面には加熱用電極を形成した。両電極のPGの厚さはいずれも $80\mu\text{m}$ であった。

【0031】次いで、電極が形成された上記基材を再度反応容器内に置き、温度 $2000^\circ\text{C}$ 、圧力1 torrに保持後、窒素ガスで希釈した三塩化ほう素とアンモニアの混合ガスを反応容器内に導入してP-BNのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、静電チャック用電極の給電部と加熱用電極の給電部のP-BN除去及び表面の研磨仕上げを行なってホットプレートを作製した。なお、P-BN被覆膜の厚さは $200\mu\text{m}$ であった。

#### 【0032】比較例3

基材としてP-BN円板のかわりに窒化アルミニウム( $\text{AlN}$ )焼結体円板を用いたこと以外は実施例3と同一の条件でPGのCVDを行なったところ、 $\text{AlN}$ が分解・気化して基材が著しく変形しホットプレートの作製は不可能であった。

#### 【0033】実施例4

外径 $70\text{mm}$ 、厚さ $0.9\text{mm}$ のP-BN円板を基材として反応容器内に置き、温度 $1800^\circ\text{C}$ 、圧力3 torrに保持後、窒素ガスで希釈したプロパンガスを反応容器内に導入してPGのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、不要部分のPGを機械加工で除去し、一方の片面には静電チャック用電極を、もう一方の面には加熱用電極を形成した。両電極の

PGの厚さはいずれも $30\mu\text{m}$ であった。

【0034】次いで、電極が形成された上記基材を再度反応容器内に置き、温度 $2000^\circ\text{C}$ 、圧力1 torrに保持後、窒素ガスで希釈した三塩化ほう素とアンモニアの混合ガスを反応容器内に導入してP-BNのCVDを行なった。CVD後、反応容器を室温まで冷却して基材を取り出し、静電チャック用電極の給電部と加熱用電極の給電部のP-BN除去及び表面の研磨仕上げを行ない、さらに静電チャック用電極面側に皿もみを設けたネジ止め用小孔を、中央付近に1個、縁部に等間隔に4個、電極を損傷しない位置にあって図1に示すホットプレートを作製した。なお、P-BN被覆膜の厚さは $100\mu\text{m}$ であった。このホットプレートを定盤上に置き、ハイトゲージを用いてホットプレート中央部と端部との高さの差を求めそり量を測定したところ、 $300\mu\text{m}$ であった。

【0035】続いて、ネジ止め用小孔に皿ネジを通し、あらかじめネジ穴をあけた固定台に上記ホットプレートをネジ止めで固定した。この時、ホットプレートが変形してそりが矯正されたため固定後のそり量は $5\mu\text{m}$ であった。このホットプレートを用いて0.1 torrの真空中で静電チャック用電源からホットプレートの給電部を介して静電チャック用電極に1.2 KVの直流電圧を印加して $50\text{mm}\phi$ シリコンウェーハの吸着試験を行なったところ、 $2.0\text{gf}/\text{cm}^2$ の静電吸着力が得られた。さらに加熱用電極の給電部に電流を通じてシリコンウェーハの加熱を行なったところ、 $1000^\circ\text{C}$ 以上まで加熱することができた。

#### 【0036】比較例4

基材としてP-BN円板のかわりにBN焼結体円板を用いたこと以外は実施例4と同一の条件でホットプレートを作製したところ、そり量は $400\mu\text{m}$ であった。このホットプレートを実施例4と同様にしてネジ止めで固定台に固定しようとしたが、ネジ止め用小孔を起点としてホットプレートに亀裂が生じて破損した。比較例5

基材としてP-BN円板のかわりに外径 $70\text{mm}$ 、厚さ $5\text{mm}$ のBN焼結体円板を用いたこと以外は実施例4と同一の条件でホットプレートを作製したところ、そり量は $10\mu\text{m}$ であった。このホットプレートを実施例4と同様にしてネジ止めで固定台に固定したところ、ホットプレートに亀裂は起こらず、また、ネジ止め前後においてそり量は変化しなかった。

【0037】このホットプレートを用いて実施例4と同一の条件でシリコンウェーハの吸着試験を行なったところ、 $1.8\text{gf}/\text{cm}^2$ の静電吸着力が得られた。さらに実施例4と同様にしてシリコンウェーハの加熱を行なったところ、 $700^\circ\text{C}$ までしかそれを加熱することができなかった。

#### 【0038】実施例5

実施例3で作製したホットプレートを $10^{-1}$  torrの真空中で $800^\circ\text{C}$ に加熱し、静電チャック用電極に5 KVの

直流電圧を印加して200mmφシリコンウェーハの吸着試験を行なったところ、40gf/cm<sup>2</sup>の静電吸着力が得られた。この時のホットプレートのP-BN被覆膜の基材面に垂直方向における比抵抗は、 $1.2 \times 10^{12} \Omega \cdot \text{cm}$ であった。

#### 【0039】比較例6

実施例3において、静電チャック用電極と加熱用電極をタングステンで形成した。タングステンの厚さは20μmであった。その後、これを反応容器内に置き、P-BN被覆膜を実施例3と同一の方法で形成したところ、タングステン電極とP-BN基材の界面付近及びタングステン電極とP-BN被覆膜の界面付近でほう化タングステンと窒化タングステンが生成していた。

【0040】上記ホットプレートの静電吸着力と比抵抗を実施例5と同一の方法で測定したところ、静電吸着力は静電チャック用電極からシリコンウェーハへの漏電が著しく5KVの直流電圧の印加が不可能であったため、測定不能であった。この時のホットプレートのP-BN被覆膜の基材面に垂直方向における比抵抗は $8 \times 10^4 \Omega \cdot \text{cm}$ であった。

#### 【0041】比較例7

P-BN被覆膜のかわりに熱分解窒化アルミニウム(P-AlN)被覆膜を形成させたこと以外は実施例3と同一の方法でホットプレートの作製を試みた。なお、P-AlN被覆膜は、温度1000℃、圧力1torrに保持後、窒素ガスで希釈した塩化アルミニウムガス( $\text{Al}_2\text{Cl}_6$ )とアンモニアの混合ガスを反応容器内に導入してCVDを行ない、形成させた。その結果、P-AlN被覆膜のCVD後、反応容器を室温まで冷却し基材を取り出した時点でP-AlN被覆膜に多数の亀裂が生じており、触れるだけその膜は容易に剝離したのでホットプレートの作製は不可能であった。

#### \*【0042】

【発明の効果】本発明のホットプレートをCVD装置に用いることにより、従来困難であったシリコンウェーハ等の試料を高精度かつ均一に高温加熱をすることができ、従って、シリコンウェーハ等の試料上に膜質や膜厚が均一な層間絶縁膜や保護膜などを形成することが可能となり半導体素子の生産性や品質の向上に大きく寄与する。

#### 【図面の簡単な説明】

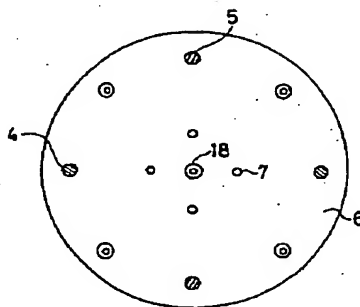
10 【図1】 本発明の実施例4で作製されたホットプレートの平面図。

【図2】 本発明の実施例4で作製されたホットプレートを装備した枚葉式CVD装置の概略断面図。

#### 【符号の説明】

- 1 基材
- 2 静電チャック用電極
- 3 加熱用電極
- 4 静電チャック用電極の給電部
- 5 加熱用電極の給電部
- 20 6 熱分解窒化ほう素被覆膜
- 7 不活性ガス導入用小孔
- 8 真空容器
- 9 ホットプレート
- 10 試料
- 11 不活性ガス
- 12 排気口
- 13 真空ポンプ
- 14 ガス導入口
- 15 反応ガス
- 30 16 静電チャック用電源
- 17 加熱用電源
- \* 18 ネジ止め用小孔

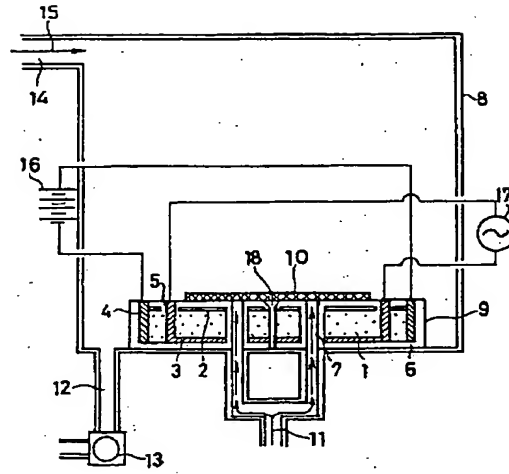
【図1】



(6)

特開平5-129210

【図2】



# PATENT ABSTRACTS OF JAPAN

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(71)Applicant : DENKI KAGAKU KOGYO KK

(22)Date of filing : 01.11.1991

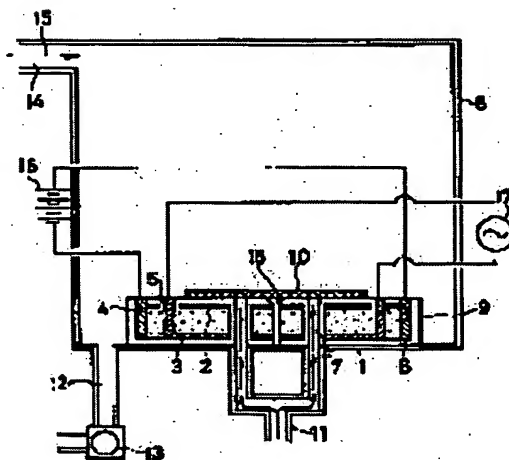
(72)Inventor : KAWASAKI TAKU  
TSUKIJIHARA MASAO  
IKEDA TAKASHI

(54) HOT PLATE

(57)Abstract:

PURPOSE: To provide a hot plate which enables high precision and uniform high temperature heating of a sample such as a silicon wafer.

CONSTITUTION: An electrostatic chuck electrode 2 is formed in one side of a base material 1 which consists of pyrolytic boron nitride, and a heating electrode 3 is formed in the other side thereof; both of them are formed of pyrolytic graphite. A pyrolytic boron nitride coat film 6 is applied to a part excepting power supply part 4 of an electrostatic chuck electrode and a power supply part 5 of a heating electrode.



## LEGAL STATUS

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**CLAIMS**

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[Claim(s)]

[Claim 1] A hot plate characterized by each coming to form an electrode for heating (3) with pyrolytic graphite in a field of another side for an electrode for electrostatic chucks (2) to one field of a base material (1) which consists of a pyrolysis boron nitride, and moreover coming to give a pyrolysis boron-nitride coat film (6) to a portion except the feed section (4) of an electrode for electrostatic chucks, and the feed section (5) of an electrode for heating.

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to a suitable hot plate to use it for heating of a sample in the process which forms an integrated circuit in samples, such as a silicon wafer which consists of an electrical conducting material or a semiconductor material.

[0002]

[Description of the Prior Art] the process which forms an interlayer insulation film and a protective coat in samples, such as a silicon wafer, -- setting -- chemistry gaseous-phase vacuum evaporation (CVD) -- law is used. In a CVD method, when the sample and reactant gas which were heated by reaction temperature contact, a chemical reaction arises on a sample and a film is formed. Membranous construction material is selected by the class of reactant gas, and membranous quality and thickness are further adjusted on condition that the existence of the pressure of CVD, temperature, and the plasma etc. And the temperature of CVD is controlled by methods, such as resistance heating, induction heating, and infrared heating. The method of heating especially one sample at a time with a hot plate is a method suitable for being called single wafer processing and controlling temperature by high degree of accuracy.

[0003] However, in heating of the conventional single wafer processing, there was a problem that contact of a sample and a hot plate serves as an ununiformity, temperature distribution arose in a sample side and distribution of membranous quality or thickness became an ununiformity by the camber of the sample generated with heating. Although it tried making inert gas, such as helium which is easy to transmit heat, intervene between a sample and a hot plate that this should be improved, since CVD was performed under reduced pressure in many cases and was not able to make the pressure of inert gas high, sufficient effect was not acquired.

[0004]

[Problem(s) to be Solved by the Invention] The object of this invention solves the above-mentioned defect, and is to offer the hot plate which made possible heating at high temperature of high degree of accuracy and a uniform sample.

[0005]

[Means for Solving the Problem] That is, each comes to form the electrode 3 for heating with pyrolytic graphite in a field of another side for the electrode 2 for electrostatic chucks to one field of the base material 1 which consists of a pyrolysis boron nitride, and, moreover, this invention is a hot plate characterized by coming to give the pyrolysis boron-nitride coat film 6 into a portion except the feed section 4 of an electrode for electrostatic chucks, and the feed section 5 of an electrode for heating.

[0006] Hereafter, this invention is explained in more detail. An outline cross section of a sheet-fed type CVD system which equipped drawing 1 with it for a plan showing an example of a hot plate of this invention is shown in drawing 2.

[0007] The base material 1 used by this invention consists of a pyrolysis boron nitride (P-BN). P-BN is a boron nitride (BN) which it comes to form with a CVD method. If materials other than P-BN are used as

a base material 1, since a pyrolysis of the base material itself or a reaction of a base material and reactant gas arises at the time of CVD, it is not desirable. Moreover, although using BN sintered compact for a base material was also considered, since BN sintered compact had the small mechanical strength, it had to thicken thickness of a base material, and since quantity of heat which moreover escapes from the base material side was also large, when it was going to heat a sample to a temperature higher than especially 700 degrees C, it had the problem that temperature did not fully go up.

[0008] When too thick [ if thickness of a base material 1 is too thin, it will become inadequate insulating between an electrode for electrostatic chucks and an electrode for heating, and ], since heat propagation comes to be hard in the thickness direction and precision of temperature control falls, 0.5-10mm is desirable. When P-BN is used for a base material, camber may occur by electrostatic chuck, but since P-BN is rich in elasticity, it can correct it easily by fixing using a screw etc. and applying force, in case a single-wafer-processing CVD system is equipped.

[0009] A hot plate of this invention makes it requirements to form the electrode 3 for heating in one field of the above-mentioned base material for the electrode 2 for electrostatic chucks with pyrolytic graphite (PG) in a field of another side, respectively. PG means a graphite which it comes to form with a CVD method.

[0010] In having formed the above-mentioned electrode 2 or 3 with materials other than PG, in the bottom so that an elevated temperature at the time of forming the P-BN coat film 6, or the time of an activity of a hot plate, the above-mentioned electrode 2, or 3 and a base material 1 react, an electrode is disconnected by the difference in both thermal expansion coefficient, or it exfoliates.

[0011] as thickness of the electrode 2 for electrostatic chucks, or the electrode 3 for heating, when too thin, resistance of an electrode for heating serves as size, and excessive voltage is needed for a heating power supply -- if too thick, since it carries out, and an electrode will become easy to exfoliate from a base material on the other hand -- 10 micrometers - being referred to as 1mm is desirable.

[0012] In this invention, a reason for constituting the feed section 4 of an electrode for electrostatic chucks and portions other than feed section 5 of an electrode for heating from a P-BN coat film is for preventing that an element on not reducing electrostatic chuck force and a sample is destroyed by fault current etc. BN coat film which it comes to form with a CVD method with a P-BN coat film -- saying -- as the thickness -- 10 micrometers - 1mm is desirable.

[0013] A hot plate of this invention can be manufactured by removing a P-BN coat film of a portion used as the feed section 4 of an electrode for electrostatic chucks, and the feed section 5 of an electrode for heating, after removing PG with a CVD method, and machining after a coat etc. removing unnecessary PG portion to the above-mentioned base material 1, making the electrode 2 for electrostatic chucks, and the electrode 3 for heating form and forming the P-BN coat film 6 with a CVD method further.

[0014] a base material top with which a CVD method has been arranged in a reaction chamber -- or a base material top with which an electrode was formed -- the bottom of inert gas ambient atmospheres, such as nitrogen and an argon, and pressure A chemical reaction is made to cause on 0.1 - 50torr and conditions with a temperature of 1700-2000 degrees C, and a film is made to form. as reactant gas -- PG -- a propane ( $C_3H_8$ ) and acetylene ( $C_2H_2$ ) etc. -- hydrocarbon gas -- P-BN -- 3 chlorination boron ( $BCl_3$ ) etc. -- mixed gas, such as halogenation boron and ammonia ( $NH_3$ ), is mainly used.

[0015] Approximate account drawing of a single-wafer-processing CVD system equipped with a hot plate of this invention is shown in drawing 2. The hot plate 9 of this invention is placed into a vacuum housing 8, it is fixed on a hot plate and a sample 10 is heated. A sample is fixed by electrostatic attraction generated by impressing voltage to an electrode for electrostatic chucks, and heating is performed by passing current from the power supply 17 for heating to the electrode 3 for heating through the feed section 5. In addition, 18 is the stoma for screw stops by which countersinking was prepared in an electrode side side for electrostatic chucks.

[0016] To a hot plate of this invention, in order to make transfer of heat from a hot plate to a sample into homogeneity, it is desirable to form the stoma 7 for introducing inert gas 11, such as helium. When introducing inert gas, since a sample will come floating if the pressure surpasses electrostatic attraction

per unit area of a sample, caution is required.

[0017] After a sample is fixed as above-mentioned, exhaust air is performed by vacuum pump 13 from an exhaust port 12, and the inside of a vacuum housing is held at a constant pressure. Furthermore a hot plate is heated and the inside of a vacuum housing is held at constant temperature. Then, reactant gas 15 is introduced from a gas inlet 14, and a CVD film is given to a sample front face.

[0018] With a CVD method, a use of a hot plate of this invention is not restricted to a process which forms an interlayer insulation film and a protective coat in a sample, and can be used for sample heat-treatment processes, such as epitaxial growth, plasma CVD, physical gaseous-phase vacuum evaporation, and plasma etching.

[0019]

[Example] Hereafter, an example and the example of a comparison are given and this invention is explained still more concretely.

[0020] The mixed gas of the 3 chlorination boron which placed the base material which consists of a graphite board with example 1 length of 500mm, a width of face [ of 250mm ], and a thickness of 5mm into the reaction container, held to the temperature of 1950 degrees C and pressure 1torr, and was diluted with nitrogen gas, and ammonia was introduced, and CVD of P-BN was performed. After CVD, the reaction container was cooled to the room temperature and ejection and P-BN which deposited were released from mold for the base material from the base material. The obtained P-BN board was machined, the P-BN disk with an outer diameter [ of 200mm ] and a thickness of 2mm was produced, and it considered as the base material.

[0021] The base material which consists of the above-mentioned P-BN disk was placed into the reaction container, after holding to the temperature of 1850 degrees C, and pressure 6torr, the liquefied petroleum gas diluted with nitrogen gas was introduced in the reaction container, and CVD of PG was performed. After CVD, the reaction container was cooled to the room temperature, PG of ejection and a garbage was removed for the base material by machining, the electrode for electrostatic chucks was formed in one one side, and the electrode for heating was formed in another field. the thickness of PG of an electrode -- each -- 50 micrometers it was .

[0022] Subsequently, the above-mentioned base material with which the electrode was formed was again placed into the reaction container, after holding to the temperature of 1950 degrees C, and pressure 1torr, the mixed gas of the 3 chlorination boron diluted with nitrogen gas and ammonia was introduced, and CVD of a pyrolysis boron nitride (P-BN) was performed. After CVD, the reaction container was cooled to the room temperature, ejection, P-BN clearance of the feed section of the electrode for electrostatic chucks and the feed section of the electrode for heating, and surface polish finishing were performed for the base material, and the hot plate was produced. in addition, the thickness of a P-BN coat film -- 150 micrometers it was .

[0023] When the above-mentioned hot plate was heated at 800 degrees C in the vacuum of 10-3torr, the direct current voltage of 3kV was impressed to the electrode for electrostatic chucks through the feed section from the power supply for electrostatic chucks and the adsorption test of 150mmphi silicon wafer was performed, it is 25 gf/cm<sup>2</sup>. Electrostatic adsorption power was acquired.

[0024] Subsequently, the above-mentioned hot plate was attached so that the electrode side for electrostatic chucks might become a single-wafer-processing CVD system upward. 150mmphi silicon wafer was placed on the hot plate, the direct current voltage of 3kV was impressed to the electrode for electrostatic chucks, the silicon wafer was fixed, and the silicon wafer was heated to 700 degrees C through current in the feed section of the electrode for heating, carrying out evacuation of the inside of equipment.

[0025] The temperature distribution within the silicon wafer side at the time of temperature becoming almost fixed were \*\*30-degree C dispersion. Then, the pressure in equipment is set to 1torr, and they are a mono silane (SiH<sub>4</sub>) and ammonia (NH<sub>3</sub>). It reaches, the mixed gas of hydrogen (H<sub>2</sub>) is introduced, and it is a nitriding silicon (Si<sub>3</sub>N<sub>4</sub>). CVD was performed. 1 micrometer of thickness Si<sub>3</sub>N<sub>4</sub> Si<sub>3</sub>N<sub>4</sub> within a silicon wafer side after making it deposit When the thickness distribution was measured, there was \*\*20% of dispersion.

[0026] It examined like the example 1 except having used the hot plate in which the electrode for example of comparison 1 electrostatic chucks is not made to form. Consequently, the temperature distribution within the silicon wafer side at the time of temperature becoming almost fixed were \*\*120-degree C dispersion. 1 micrometer of moreover, thickness Si<sub>3</sub>N<sub>4</sub> Si<sub>3</sub>N<sub>4</sub> within the silicon wafer side after making it deposit The thickness distribution was \*\*60% of dispersion.

[0027] Four stomata for inert gas installation with a diameter of 5mm were opened in the location of 80mm at equal intervals from the center of a P-BN disk with an outer diameter [ example 2 / of 250mm ], and a thickness of 3mm. Then, the hot plate was produced like the example 1, it attached in the single-wafer-processing CVD system, and the silicon wafer was heated.

[0028] when the temperature of a silicon wafer became about 1 law, and gaseous helium was introduced by the pressure of 5torr(s) and held from the stoma for inert gas installation of a hot plate for 1 hour, the temperature distribution within a silicon wafer side were \*\*10-degree C dispersion. Then, the pressure in equipment is set to 1torr, and they are a mono silane (SiH<sub>4</sub>) and ammonia (NH<sub>3</sub>). It reaches, the mixed gas of hydrogen (H<sub>2</sub>) is introduced, and it is a nitriding silicon (Si<sub>3</sub>N<sub>4</sub>). CVD was performed. 1 micrometer of thickness Si<sub>3</sub>N<sub>4</sub> Si<sub>3</sub>N<sub>4</sub> within a silicon wafer side after making it deposit When the thickness distribution was measured, it was \*\*10% of dispersion.

[0029] It examined like the example 2 except having used the hot plate in which the electrode for example of comparison 2 electrostatic chucks is not made to form, and having set the introductory pressure of the gaseous helium from a stoma to 1torr. Consequently, the temperature distribution within the silicon wafer side 1 hour after gaseous helium installation were \*\*80-degree C dispersion. 1 micrometer of moreover, thickness Si<sub>3</sub>N<sub>4</sub> The thickness distribution of Si<sub>3</sub>N<sub>4</sub> within the silicon wafer side after making it deposit was \*\*40% of dispersion.

[0030] The same base material as example 3 example 2 was placed into the reaction container, after holding to the temperature of 1900 degrees C, and pressure 10torr, the liquefied petroleum gas diluted with nitrogen gas was introduced in the reaction container, and CVD of PG was performed. After CVD, the reaction container was cooled to the room temperature, PG of ejection and a garbage was removed for the base material by machining, the electrode for electrostatic chucks was formed in one one side, and the electrode for heating was formed in another field. Each thickness of PG of two electrodes was 80 micrometers.

[0031] Subsequently, the above-mentioned base material with which the electrode was formed was again placed into the reaction container, after holding to the temperature of 2000 degrees C, and pressure 1torr, the mixed gas of the 3 chlorination boron diluted with nitrogen gas and ammonia was introduced in the reaction container, and CVD of P-BN was performed. After CVD, the reaction container was cooled to the room temperature, ejection, P-BN clearance of the feed section of the electrode for electrostatic chucks and the feed section of the electrode for heating, and surface polish finishing were performed for the base material, and the hot plate was produced. in addition, the thickness of a P-BN coat film -- 200 micrometers it was .

[0032] Except having used the alumimium nitride (AlN) sintered compact disk instead of the P-BN disk as example of comparison 3 base material, when CVD of PG was performed on the same conditions as an example 3, it is AlN. It decomposed and evaporated, the base material deformed remarkably, and production of a hot plate was impossible.

[0033] It placed into the reaction container by using the P-BN disk of example 4 outer diameter of 70mm, and thickness 0.9 mm as a base material, and after holding to the temperature of 1800 degrees C, and pressure 3torr, the liquefied petroleum gas diluted with nitrogen gas was introduced in the reaction container, and CVD of PG was performed. After CVD, the reaction container was cooled to the room temperature, PG of ejection and a garbage was removed for the base material by machining, the electrode for electrostatic chucks was formed in one one side, and the electrode for heating was formed in another field. the thickness of PG of two electrodes -- each -- 30 micrometers it was .

[0034] Subsequently, the above-mentioned base material with which the electrode was formed was again placed into the reaction container, after holding to the temperature of 2000 degrees C, and pressure 1torr, the mixed gas of the 3 chlorination boron diluted with nitrogen gas and ammonia was introduced

in the reaction container, and CVD of P-BN was performed. After CVD, the reaction container was cooled to the room temperature, ejection, P-BN clearance of the feed section of the electrode for electrostatic chucks and the feed section of the electrode for heating, and surface polish finishing were performed for the base material, and the hot plate which opens in the location which does not damage near a center the stoma for screw stops which prepared countersinking in the electrode side side for electrostatic chucks further at one piece and a edge, and does not damage four pieces and an electrode at equal intervals, and is shown in drawing 1 was produced in addition, the thickness of a P-BN coat film -- 100 micrometers it was . the place which placed this hot plate on the surface plate, and measured the amount of camber in quest of the difference of the height of a hot plate center section and an edge using the height gage -- 300 micrometers it was .

[0035] Then, it fixed to the stoma for screw stops right through, and the above-mentioned hot plate was fixed to the standing ways in which the screw hole was made beforehand for the flat countersunk head screw by the screw stop. since the hot plate deformed and camber was corrected at this time -- the amount of camber after immobilization -- 5 micrometers it was . When the direct current voltage of 1.2 KV was impressed to the electrode for electrostatic chucks through the feed section of a hot plate using this hot plate from the power supply for electrostatic chucks in the vacuum of 0.1 torr and the adsorption test of 50mmphi silicon wafer was performed, it is 20 gf/cm<sup>2</sup>. Electrostatic adsorption power was acquired. When the silicon wafer was furthermore heated through current in the feed section of the electrode for heating, it was able to heat to 1000 degrees C or more.

[0036] the place which produced the hot plate on the same conditions as an example 4 except having used BN sintered compact disk instead of the P-BN disk as example of comparison 4 base material -- the amount of camber -- 400 micrometers it was . Although it was going to fix this hot plate to standing ways by the screw stop like the example 4, the crack was arisen and damaged to the hot plate with the stoma for screw stops as the starting point. the place which produced the hot plate on the same conditions as an example 4 except having used BN sintered compact disk with an outer diameter [ of 70mm ], and a thickness of 5mm instead of the P-BN disk as example of comparison 5 base material -- the amount of camber -- 10 micrometers it was . When this hot plate was fixed to standing ways by the screw stop like the example 4, the crack did not take place to a hot plate, and the amount of camber did not change before and after the screw stop.

[0037] When the adsorption test of a silicon wafer was performed on the same conditions as an example 4 using this hot plate, it is 18 gf/cm<sup>2</sup>. Electrostatic adsorption power was acquired. When the silicon wafer was heated still like the example 4, it was able to be heated only to 700 degrees C.

[0038] When the hot plate produced in the example 5 example 3 was heated at 800 degrees C in the vacuum of 10-5torr, the direct current voltage of 5kV was impressed to the electrode for electrostatic chucks and the adsorption test of 200mmphi silicon wafer was performed, it is 40 gf/cm<sup>2</sup>. Electrostatic adsorption power was acquired. Specific resistance [ in / to the base material side of the P-BN coat film of the hot plate at this time / a perpendicular direction ] was  $1.2 \times 10^{12}$  ohm-cm.

[0039] In example of comparison 6 example 3, the electrode for electrostatic chucks and the electrode for heating were formed with the tungsten. the thickness of a tungsten -- 20 micrometers it was . Then, when this was placed into the reaction container and the P-BN coat film was formed by the same method as an example 3, the way-ized tungsten and the nitriding tungsten were generating near the interface of a wolfram electrode and a P-BN base material, and near the interface of a wolfram electrode and a P-BN coat film.

[0040] When the electrostatic adsorption power and specific resistance of the above-mentioned hot plate were measured by the same method as an example 5, since impression of the direct current voltage whose fault current to a silicon wafer from the electrode for electrostatic chucks is 5kV remarkably was impossible for electrostatic adsorption power, it cannot be measured. Specific resistance [ in / to the base material side of the P-BN coat film of the hot plate at this time / a perpendicular direction ] is  $8 \times 10^4$ . It was omega-cm.

[0041] Production of a hot plate was tried by the same method as an example 3 except having made the pyrolysis aluminium nitride (P-AlN) coat film form instead of an example of comparison 7 P-BN coat

film. In addition, P-AlN A coat film is aluminum chloride gas ( $\text{AlCl}_3$ ) diluted with nitrogen gas after holding to the temperature of 1000 degrees C, and pressure 1 torr. The mixed gas of ammonia was introduced in the reaction container, and it was made to form by performing CVD. Consequently, P-AlN It is P-AlN, when the reaction container was cooled to the room temperature and the base material was taken out after CVD of a coat film. Since much cracks had arisen on the coat film, and the film exfoliated easily as it touched, production of a hot plate was impossible.

[0042]

[Effect of the Invention] By using the hot plate of this invention for a CVD system, heating at high temperature can be made high degree of accuracy and homogeneity for samples, such as a conventionally difficult silicon wafer. Therefore, it becomes possible to form an interlayer insulation film, a protective coat, etc. with uniform membrane quality and thickness on samples, such as a silicon wafer, and contributes to improvement in the productivity of a semiconductor device, or quality greatly.

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[Translation done.]

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] The plan of the hot plate produced in the example 4 of this invention.

[Drawing 2] The outline cross section of the single-wafer-processing CVD system equipped with the hot plate produced in the example 4 of the example of this invention.

[Description of Notations]

- 1 Base Material
- 2 Electrode for Electrostatic Chucks
- 3 Electrode for Heating
- 4 Feed Section of Electrode for Electrostatic Chucks
- 5 Feed Section of Electrode for Heating
- 6 Pyrolysis Boron-Nitride Coat Film
- 7 Stoma for Inert Gas Installation
- 8 Vacuum Housing
- 9 Hot Plate
- 10 Sample
- 11 Inert Gas
- 12 Exhaust Port
- 13 Vacuum Pump
- 14 Gas Inlet
- 15 Reactant Gas
- 16 Power Supply for Electrostatic Chucks
- 17 Power Supply for Heating
- 18 Stoma for Screw Stops

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[Translation done.]

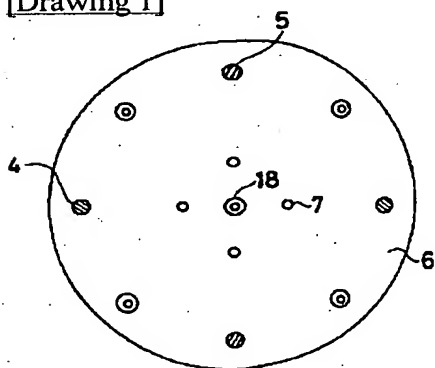
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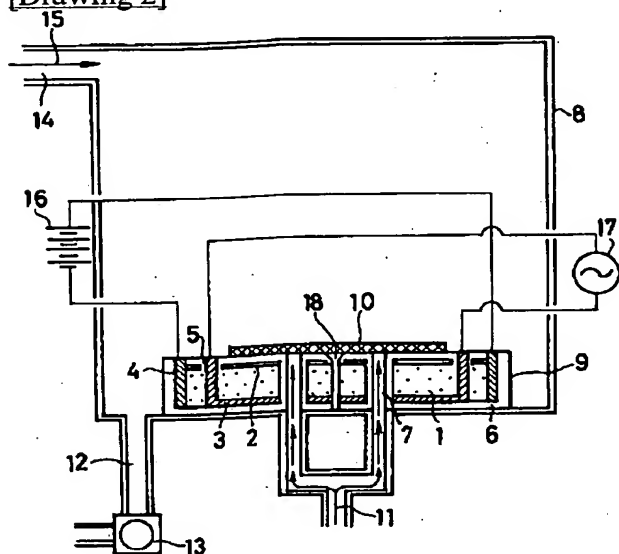
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## DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]